Name: …… ( ) Class: …….
Date: …….

Raffles Institution
Year 6 H2 Chemistry 2025

Set A T1W6 – Introduction to Organic Chemistry, Alkanes and Alkenes

Pre-ChemFocus Activity

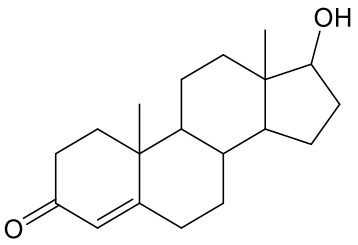
- Familiarise yourself with the following mechanisms: Free Radical Substitution of Alkanes and Electrophilic Addition of Alkenes
- To view infopack at IVY > C2025 – H2 CHEMISTRY > Pages > [ChemFocus] T1W6 Intro to Organic Chemistry, Alkanes, Alkenes > **FIRST VIDEO ONLY**

Notes:

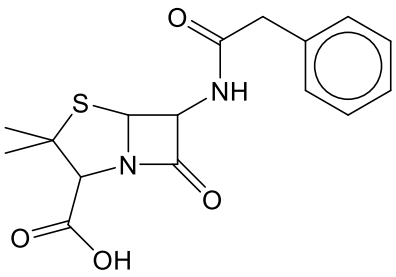
Introduction to Organic Chemistry – Stereoisomerism

1 Identification of chiral centres.

(a)



(b)



2 Illustration of stereoisomers

(a) $CH_3CH_2CH(CN)COOH$

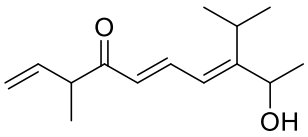
(b) $CH_3CH_2CH=CHCl$

Notes:

Self-Check Questions

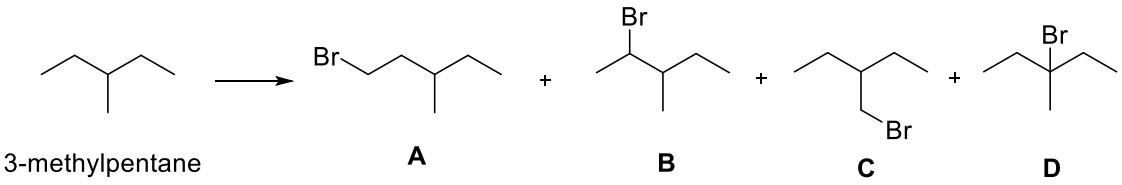
Check your answers at IVY > C2025 – H2 CHEMISTRY > Pages > [ChemFocus] T1W6 Intro to Organic Chemistry, Alkanes, Alkenes > Remaining videos

1 How many stereoisomers are possible for the following molecule?



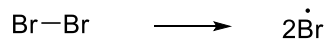
A 8 **B** 16 **C** 32 **D** 64

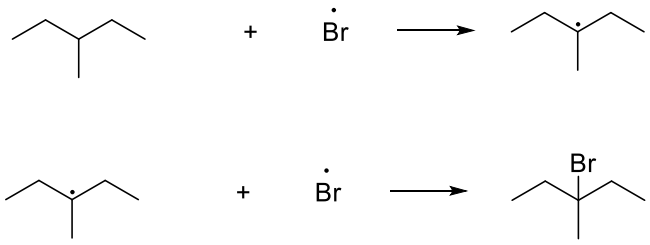
2 When 3-methylpentane reacts with bromine, four different monobrominated products are produced.

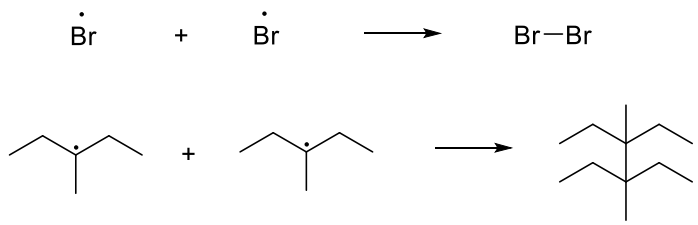


3-methylpentane **A** **B** **C** **D**

(a) A description of the reaction mechanism producing isomer **D** is illustrated in Fig 1.1. Correct the mechanism by annotating on the figure.







Learning points:

(b) State and explain the predicted ratio of the monobrominated products of 3-methylpentane.

A : **B** : **C** : **D** = ….. : ….. : ….. : …..

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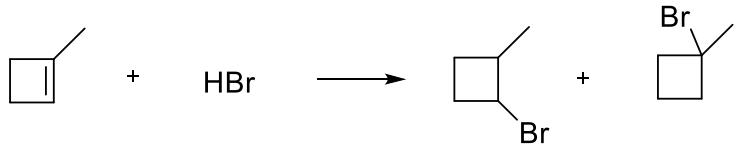
……..[3]

Learning point(s): Not all primary H atoms lead to the same product. Students need to be clear in articulating which H atoms (type and on which C) leads to a certain product.

3 When 1-methylcyclobutene reacts with hydrogen bromide, two products are produced.



1-methylcyclobutene **E** **F**

(a) A description of the reaction mechanism producing isomer **D** is illustrated in Fig 2.1. Correct the mechanism by annotating on the figure.

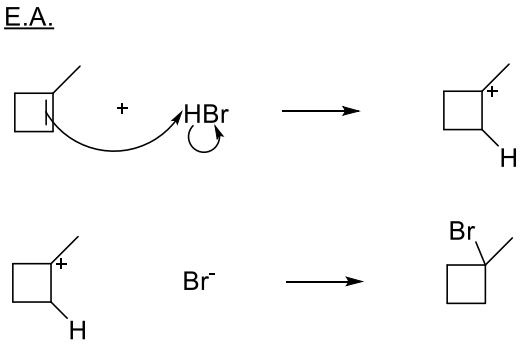


Fig. 2.1

(b) By considering the stability of the carbocation intermediate, explain why isomer **F** is the major product.

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..……[2]

Tutorial Discussion Questions (to complete before Chemfocus session)

1a 2-methylpropane can react with bromine in the presence of sunlight to give two monobrominated products, 1-bromo-2-methylpropane and 2-bromo-2-methyl propane.

(i) Predict the ratio of 1-bromo-2-methylpropane to 2-bromo-2-methylpropane.

……..[1]

(ii) When the chlorination is carried out and the product are analysed, it is found that the mole ratio of 1-bromo-2-methylpropane to 2-bromo-2-methylpropane formed is about 3:2.

Suggest an explanation for the difference between this ratio and the one you gave in **(i)**.

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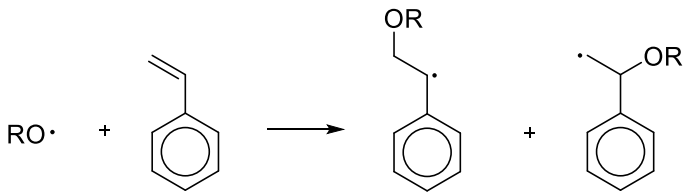
……..[2]

Learning point(s): final product ratio is not just determined by the ratio of H present, but also determined by the rate of abstraction, which is affected by the stability of the radical intermediate.

2a Phenylethene can undergo free radical addition reaction with organic peroxide radical, RO•. The reaction can proceed through two radical intermediates as shown below.



Suggest whether **P** or **Q** would be the major species formed during the reaction.
Explain your answer.

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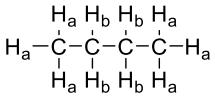
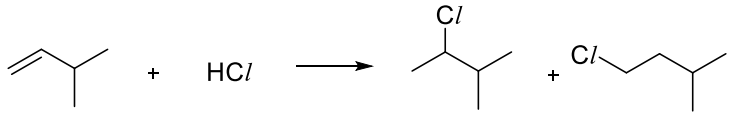
……[2]

Tutorial Practice Questions (to be attempted **IN CLASS**)

1b Compounds **A** and **B** have molecular formula C_4H_{10}. **A** has a higher boiling point than **B**. When **A** reacts with chlorine gas in the presence of light, three products with the formula of C_4H_9Cl, **C**, **D** and **E** are formed, amongst which, **D** and **E** are optical isomers. When **B** undergoes the same reaction, only two products, **F** and **G**, are formed. **F** and **G** do not exhibit enantiomerism.

Information	Deductions
Compounds **A** and **B** have molecular formula C_4H_{10}.	Possible structures of **A** and **B**:
A has a higher boiling point than **B**.	**A** is _____ branched and has _____ _____ _____ available for instantaneous dipole-induced dipole (id-id) interactions. Hence, **A** has _____ id-id interactions than **B**. **A** is: **B** is:
When **A** reacts with chlorine gas in the presence of light, three products with the formula of C_4H_9Cl, **C**, **D** and **E** are formed, amongst which, **D** and **E** are optical isomers.	**A** has _____ unique H atoms that can undergo free radical substitution with Cl_2.  Substitution of ____ produces isomer C, which does not have a chiral carbon. Substitution of ____ produces a product with a chiral carbon. **C** is: **D** and **E** are:

2b When compound **R** reacts with HC*l*(g), a mixture of compound **S** and **T** were obtained.



R **S** **T**

Despite having a chiral carbon in **S**, the final mixture of the reaction was found to be optically inactive. With the aid of a diagram, explain why.

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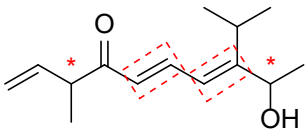
……[3]

Self-Check Answers

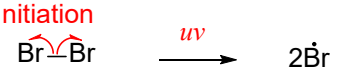
1.



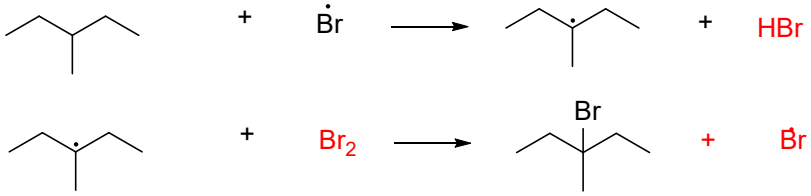
No. of chiral carbons = 2
No. of double bonds that gives rise to cis-trans isomerism = 2
Total number of stereoisomers = $2^{(x+y)} = 2^4 = 16$

2 **(a)** Free Radical Substitution

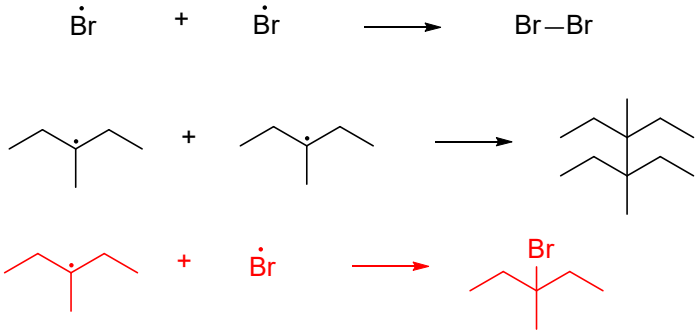
Initiation



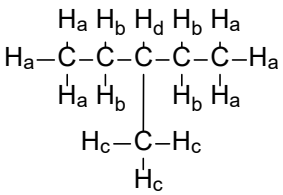
Propagation



Termination

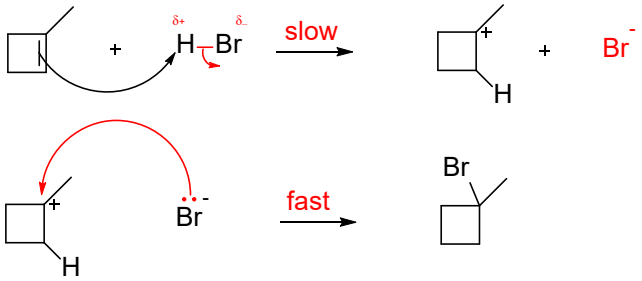


(b) **A** : **B** : **C** : **D** = **6 : 4 : 3 : 1**



To form **A**, Br atom can replace any of the 6 primary H_a.
To form **B**, Br atom can replace any of the 4 secondary H_b.
To form **C**, Br atom can replace any of the 3 primary H_c.
To form **D**, Br atom can replace 1 tertiary H_d.

3 **(a)** Electrophilic Addition



(b)

carbocation of **F** carbocation of **G**

Carbocation of **F** is more stable than that of **G**. The carbocation of **F** has 3 electron donating groups bonded to the carbon atom with a positive charge, compared to 2 in that of **G**. The positive charge on carbon in F is dispersed to a greater extent.

Set A Tutorial Discussion Questions (to complete before Chemfocus session)

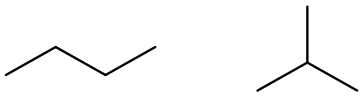
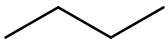
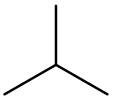
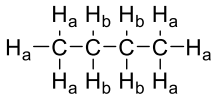
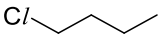
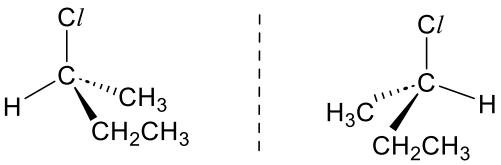
1a **(i)** 9:1

(ii) The tertiary free radical produced when the tertiary hydrogen is substituted to form 2-bromo-2-methylpropane is significantly more stable due to the presence of 3 electron donating groups causing the radical carbon to be less electron deficient, compared to 1 electron donating group in that of the primary free radical formed when one primary hydrogen is substituted to form 1-bromo-2-methylpropane.

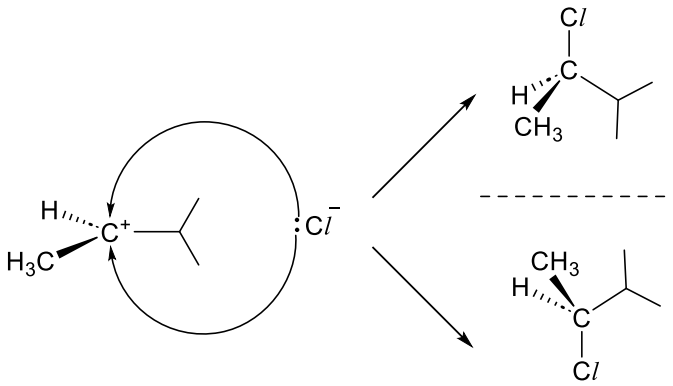
2a Free radical **P** would be the major species because it is a secondary radical and the orbital containing the lone-electron overlaps with the π-electron cloud of benzene. The π-electrons in benzene delocalises into the orbital of the radical, resulting in the C with a lone electron to be less electron deficient, hence more stable.

Set A Tutorial Practice Questions (to be attempted **IN CLASS**)

1b

Information	Deductions
Compounds **A** and **B** have molecular formula C_4H_{10}.	Possible structures of **A** and **B**: 
A has a higher boiling point than **B**.	**A** is less branched and has greater surface area available for instantaneous dipole-induced dipole (id-id) interactions. Hence, **A** has stronger id-id interactions than **B**. **A** is:  **B** is: 
When **A** reacts with chlorine gas in the presence of light, three products with the formula of C_4H_9Cl, **C**, **D** and **E** are formed, amongst which, **D** and **E** are optical isomers.	**A** has 2 unique H atoms that can undergo free radical substitution with Cl_2.  Substitution of H_a produces isomer C, which does not have a chiral carbon. Substitution of H_b produces a product with a chiral carbon. **C** is:  **D** and **E** are: 

2b



The positively charged carbon has a trigonal planar shape. The Cl^- ion can attack the positively charged carbon from either side of the plane with equal likelihood. The product is a racemic mixture of **S**, while **T** is not chiral. Hence the final mixture does not have optical activity.